Towards a Roadmap for a Resource Efficient and Effective Manufacturing Industry in Sweden

Milios, Leonidas; Dalhammar, Carl; Sakao, Tomohiko; Lindahl, Mattias

Published in:
Proceedings of EcoDesign 2019 conference

2019

Towards a Roadmap for a Resource Efficient and Effective Manufacturing Industry in Sweden

Leonidas Milios [1], Carl Dalhammar [1], Tomohiko Sakao [2], Mattias Lindahl [2]

[1] International Institute for Industrial Environmental Economics (IIIEE), Lund University, Lund, Sweden

[2] Department of Management and Engineering, Linköping University, Linköping, Sweden

Abstract

The transition to a resource efficient economy that makes effective use of raw materials and energy is a multi-level dynamic process requiring a wide systems perspective. To operationalize this transition in a holistic manner, the concept of Circular Economy (CE) has been championed by major economies around the world. The idea with CE is to strive towards maximizing the utilization of products, components and materials and their embedded material value throughout the economy, generating the lowest possible amount of loss and waste in relation to the obtained value. This contribution presents the main elements for a transition roadmap towards CE in the Swedish manufacturing sector. This paper presents (i) a baseline of resource efficiency operations in Sweden and existing strategies for CE transition in the EU; (ii) outlines major areas of opportunity for the Swedish manufacturing sector to innovate and create resource efficient and effective solutions; (iii) identifies a variety of stakeholders that are required to intervene in different levels (local/regional/national/international, as well as public/private), scales and timeframes; and (iv) presents a comprehensive set of actions and policies, including monitoring and evaluation, as a direct recommendation to political and business actors in Sweden. Finally, milestones are defined and a timeframe for the roadmap is proposed.

Keywords:

Circular Economy, Transition Roadmap, Resource Efficiency, Manufacturing Industry

1 INTRODUCTION

Over the last century, the global use of natural resources has increased eightfold [1-2] while there is no sign of a slowdown yet. In total, 92.8 billion tons of resources entered the global economy in 2015 [3] and this amount keeps growing as material resource use could double between 2015 and 2050, reaching 186 billion tons [4].

Directly associated with the increase in natural resource use is an increase in the pressure on the environment. It is recognized that human activity is destabilizing the natural systems and as a result “planetary boundaries” [5] may be exceeded. These changes are apparent from issues such as climate change [6-7], the rapid decline in global biodiversity [8-9], and the rising pressure on the remaining areas of natural land [10], among others.

Efficiency approaches constitute an important first step towards reducing resource use and the associated negative environmental impacts as they can reduce the use of resources per unit of output [11]. However, more fundamental strategies and measures are required, since the actual potential of efficiency approaches is limited in the light of rising customer demand [12]. Moreover, rebound effects may prevent efficiency improvements from reducing resource use in absolute terms [13-14]. In addition, while efficiency can mitigate the business risks arising from a dependency on primary materials obtained from volatile global raw materials markets, it cannot completely eliminate them.

Therefore, a revised and more holistic approach for production and use systems has been proposed in the European Union (EU) in recent years, the so-called Circular Economy (CE). This “new” concept goes beyond the resource efficiency and productivity approaches. It is a strategy which promotes environmentally sound economic systems and is based on well-established scientific disciplines such as industrial ecology and ecological economics [15-16]. Its main objective is to minimize negative environmental impacts by a qualitative and quantitative transformation of production systems and by closing and slowing down resource flows. The implementation of CE practices is accordingly intended to decouple the rate of economic growth from an increase in environmental impact [17].

Therefore, from a sustainability perspective, CE offers the opportunity to reduce the economy’s ecological footprint by lowering raw material use and consumption and minimizing the production of waste, as well as keeping the value of resources for as long as possible and rethinking processes throughout the value chain [18].

The circular economy could also play a significant role in achieving the Paris Climate Agreement’s objective to maintain global temperatures to below the 2 degrees Celsius threshold above pre-industrial levels as half of the world greenhouse gas emissions could be linked to the extraction, processing, use and disposal of materials [19].

The circular economy is an essential building block not only for the implementation of Sustainable Development Goal (SDG) 12 to "ensure sustainable use and production patterns" but also various other SDGs, being also indirectly linked to 6, 8, 9, and 11-15 [20].

Natural resource use in Sweden causes environmental pressures both domestically and abroad. Sweden had a domestic material consumption (DMC) equal to about 23 tons per capita in 2015, which is among the highest in the EU [21]. The material use and consumption has been steadily increasing since the beginning of the 21st century [21]. Similarly, waste generation has constantly increased during the last 42 years in record, from about 3.7 million tons in 1975 to 4.8 million tons in 2017 [22]. Consumption of resources and waste generation are inexorably linked with economic magnification and in the case of Sweden the sustained economic growth observed in the last decades has contributed to the increase in consumption and waste. However, Sweden has installed a comprehensive waste management framework with high rates of recycling (material and organic) representing almost 50% of collected waste [22]. Alarming is the fact that this rate has not increased over the last 15 years, but remained stagnant, indicating that the recycling efforts in Sweden have reached a limit [22-24]. Thus, a new approach in management of resources is imperative in the case of Sweden.

The start of a transition towards CE is an important strategic decision, implying the passage from "necessity" – efficiency in the use of resources, rational management of waste – to "opportunity" by designing products that can be used for longer and re-used after reaching a certain end-of-life (EOL).

At the forefront of a national effort to move towards a CE stands the Swedish manufacturing sector. The manufacturing sector is an indispensable pillar of the Swedish economy, responsible for 77% of Swedish exports and contributing 20% of the national gross domestic product (GDP) [25]. Therefore, this contribution aims to present a comprehensive plan towards the creation of a "Roadmap for a Resource Efficient and Effective Manufacturing Industry in Sweden", based on CE principles.

The creation of a national industrial roadmap to achieve high impact goals, such as the transition of an entire industry towards a novel paradigm, is a formidable task and requires several steps and wide stakeholder participation. In the current contribution, we outline the foundations for this process by preparing the necessary science-based background that is required to inform stakeholder interactions in every step of the way. For this reason, we provide in the following sections: a background on the concept of CE and its associated principles; the current situation of the manufacturing industry in Sweden; the policy background related to resources and waste; a brief review of existing CE roadmaps from EU Member States; a framework for the transition together with a proposed timeline; and indicators for measuring progress, followed by a few concluding remarks. But first, the next section presents the methodology for developing this paper.

2 METHODOLOGY

The main objective of this contribution is to provide a comprehensive background for guiding the process of developing a roadmap for a resource efficient and effective manufacturing industry in Sweden. The approach of research is based on a literature review including both academic literature and grey literature, including governmental reports and policy documents, depending on the information requirements of each section. For instance, sections 3 and 8 about the concept of CE and for defining CE indicators, the literature review was based primarily on scientific sources, using the common search outlets "ScienceDirect" and "Scopus" to retrieve relevant literature. We capitalized on the recent surge of interest on the terms of CE and CE indicators, as portrayed by the boom in the number of publications over the last three years [26]. Extensive reviews on the concepts facilitated the swift and comprehensive development of the background sections both in CE principles (for instance [27-30]) and CE indicators [26, 31-32]. For the policy (section 5) and manufacturing background (section 4) of Sweden, we analyzed relevant governmental and industry reports retrieved from governmental portals and agencies as well as industrial organizations.

For the review of existing CE roadmaps, we developed a framework of analysis to facilitate the extraction of necessary elements required in the development of a roadmap. Core elements of strategic target setting and "road-mapping" include at least the following: (i) Vision; (ii) Scope; (iii) Actors; (iv) Targets and monitoring; (v) Actions and Implementation plan; (vi) Evaluation [33]. The analysis of the existing CE roadmaps, therefore, followed the six parameters included in the framework. The national CE roadmaps analyzed in this paper included those of Denmark [34], Finland [35], France [36], Italy [37], Netherlands [38], Portugal [39], Slovakia [40], Slovenia [41] and Scotland [42].

Based on the observations in the national CE roadmaps, we sketch out a preliminary framework for transition to CE, which will form the basis of discussion and scrutiny in future industry and policy workshops within the process of the roadmap development. The rationale of the framework and the potential transition governance elements are discussed in section 7.

3 BACKGROUND ON CIRCULAR ECONOMY

3.1 How to define a circular economy?

The circular economy (CE) is an emerging approach aimed at the sustainable use of natural resources [43]. The

Restricted article - work in progress

Full version available in conference USB proceedings